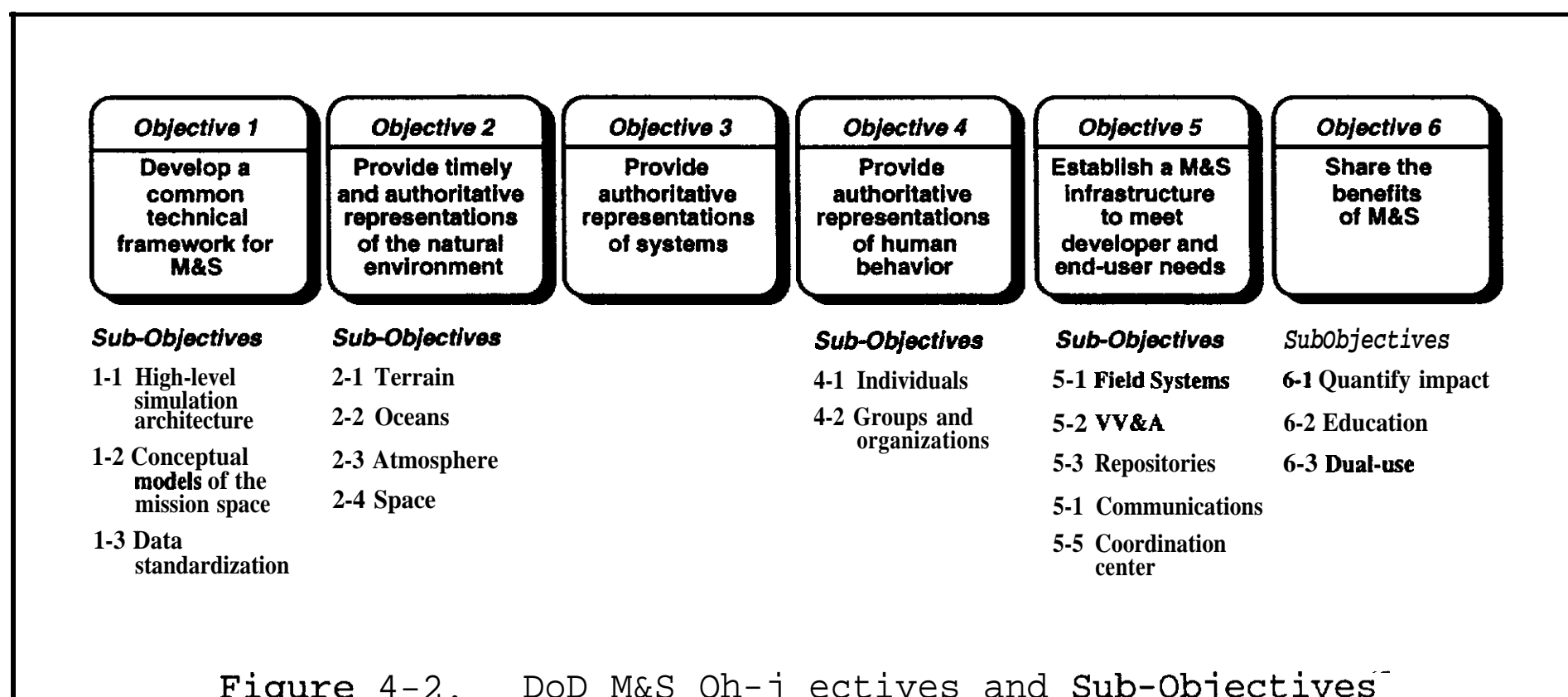CHAPTER 4

DOD M&S OBJECTIVES

A. __INTRODUCTION__ . The baseline M&S assessment and an analysis of the activities described in the DoD M&S activity model identified many shortfalls that must be corrected to realize the DoD M&S vision. The set of actions outlined here are designed to effi- ciently encourage early and continued use of M&S in accord with the vision. Six DoD-wide objectives were derived by the logic depicted in Figure 4-1. M&S applications are found though-out the Department of Defense. A single model or simulation can fulfill only a modest set of needs. Therefore, the objectives do not speak, per se, to any specific application whose contents are driven by application needs. Instead, the objectives address those aspects of M&S that may be common and which will ens.ure **in- teroperability** where appropriate. For each objective, this plan



Figure 4-1.  Logic for Deriving M&S Objectives
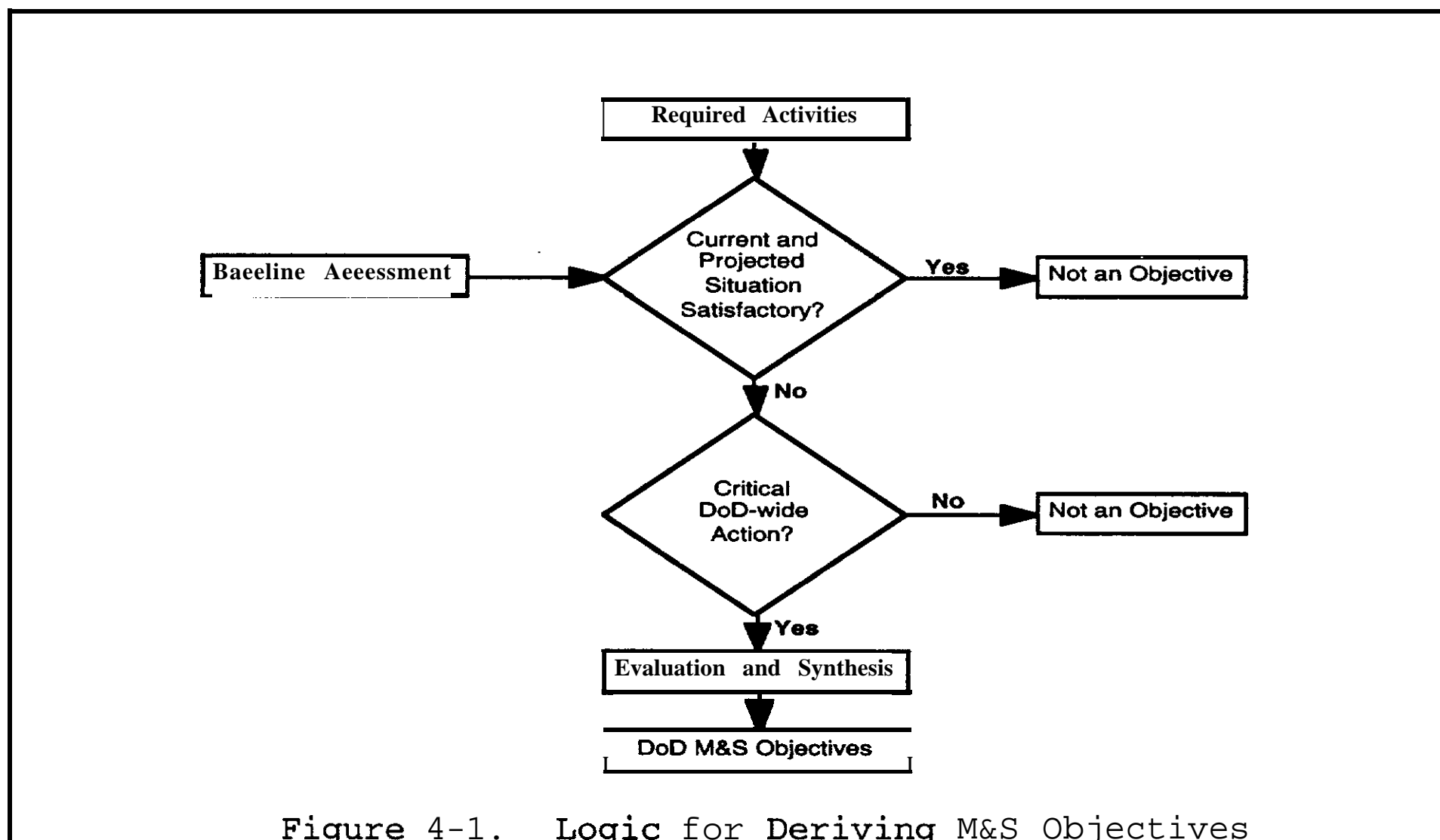
identifies key issues and actions. Achieving these objectives will take significant time and resources, and require a DoD-wide coordinated effort. Figure 4-2 shows the six objectives and the breakout of the objectives into sub-objectives. The following sections discuss each objective and sub-objective and identify the major issues and actions that the Department of Defense needs to take to accomplish each objective and/or sub-objective. Where assigned, the DoD organization with primary responsibility (PR) for each action is also identified.

| Objective 1 | Objective 2 | Objective 3 | Objective 4 | Objective 5 | Objective 6 |
|---|---|---|---|---|---|
| Develop a common technical framework for M&S | Provide timely and authoritative representations of the natural environment | Provide authoritative representations of systems | Provide authoritative representations of human behavior | Establish a M&S infrastructure to meet developer and end-user needs | Share the benefits of M&S |

| *Sub-Objectives* | *Sub-Objectives* | | *Sub-Objectives* | *Sub-Objectives* | *SubObjectives* |
|---|---|---|---|---|---|
| 1-1 High-level simulation architecture | 2-1 Terrain | | 4-1 Individuals | 5-1 Field Systems | 6-1 Quantify impact |
| 1-2 Conceptual models of the mission space | 2-2 Oceans | | 4-2 Groups and organizations | 5-2 VV&A | 6-2 Education |
| 1-3 Data standardization | 2-3 Atmosphere | | | 5-3 Repositories | 6-3 Dual-use |
| | 2-4 Space | | | 5-1 Communications | |
| | | | | 5-5 Coordination center | |

Figure 4-2. DoD M&S Oh-jectives and Sub-Objectives

B. OBJECTIVE 1. Provide a **common** technical framework for M&S.

1. Discussion. The efficient and effective use of models and simulations across the Department of Defense requires a common technical framework for M&S to facilitate interoperability and reuse. The technical framework will consist of: a common **high-level architecture** (HLA) to which models and simulations must conform; conceptual models of the mission space **(CMMS)** to provide a basis for the development of consistent and authoritative simulation representations; and, data standards to provide **common** representations of data across models, simulations, and C4I systems.

2. **Sub-Objective 1-1**. Establish a **common** high-level simulation architecture to facilitate the interoperability of all types of simulations among themselves and with $C^4I$ systems, as well as to facilitate the reuse of M&S components.

a. Discussion. No single model or simulation system can satisfy all uses and users. To facilitate the interoperability of models and simulations as well as to allow maximum reuse of their components, the DoD requires a HLA to which simulations developed by particular DoD Components or functional areas must conform. Further definition and detailed implementation of specific simulation system **architectures** will remain the responsibility of the developing Component[13]. The HLA will specify only the minimum definition required to facilitate interoperability and reuse. The primary components of the HLA include:

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13 For example, both the Joint Simulation System and the Close Combat Tactical Trainer would both conform to the HLA, but each would also have its own more specific system architecture for purposes of implementation.

(1) Functional Definition. A set of rules which describe the functions of simulations and the services provided by the runtime infrastructure in HLA federations.

(a) Simulation Functionality. The HLA requires simulations to furnish the external functionality necessary to interact with other simulations via the runtime infrastructure according to the interface specification. The HLA makes no specification about the internal structure of simulations.

(b) Runtime Infrastructure Services. The runtime infrastructure software provides the services that allow simulations to form federations and exchange information with one another.  The HLA prescribes the nature of these services.

(2) Interface Specification.  In the HLA, simulations interact with a runtime infrastructure to establish and maintain a federation and to enhance information exchange among simulations. The HLA contains an interface specification that defines the nature of these interactions.

(3) Object Model Template. The HLA requires simulations and sets of interacting simulations ("federations") to each have an object model describing the entities represented in the simulations and across the federation.  The HLA object model template prescribes the kind of information that should be included in the object models, but it does not define the object classes (e.g., vehicles, unit types) that will appear in the object models.

b.  Issues:

(1) process for defining, evolving, and maintaining the HLA, recognizing that no one party can represent all issues.

(2) Improved cost-effectiveness of DoD M&S by ensuring broader accessibility of widely needed capabilities (e.g., entity and unit representations, environmental databases) .

(3) Adoption of architectural constructs to facilitate the reuse of all classes of M&S across all functional areas (e.g., training, analysis, and acquisition) , without unduly restricting the flexibility of individual M&S projects.

(4) Development of M&S interfaces with current and emerging $C^4I$ systems to allow operators to input data to models and simulations and to receive output from them in real-world format at live $C^4I$ systems in support of a full spectrum of applications (e.g., campaign planning, mission planning, command post exercises, and battle management training) .

(5) Identification of the full set of interfaces for which standards are required.

(6) Synchronization of models and simulations that employ different time-management methods.

(7) Adaptation of the DIS architectural concepts and standards to the HLA as DIS evolves.

(8) Reconfiguration of simulations to address new requirements.

(9) Extent to which security can be addressed in the HLA (rather than just in the treatment of individual simulations and federations of simulations).

(lo) Establishment of procedures to ensure compliance with the HLA.

c. Actions:

(1) Establish an Architecture Management Group (AMG) by second quarter fiscal year (FY) 1995. The AMG will be formed from DoD parties with major interests in M&S and modeled after open, consensus-based commercial approaches (e.g. , Internet Architecture Board, Object Management Group) . For practical · purposes, the AMG will first be formed as a small group drawn primarily from representatives of those programs that have a commitment to implementing the HLA and testing and refining it with prototypes. (PR: DDR&E)

(2) Develop alternative high-level architectural concepts by second quarter FY 1995, drawing on architectural development efforts already ongoing in DoD programs. (PR: DDR&E)

(3) Develop an initial description document for a common HLA by second quarter FY 1995. (PR: DDR&E)

(4) Coordinate with DIS standards bodies in FY 1995 to encourage the rapid evolution of DIS architectural concepts and standards to meet DoD needs. (PR: DMSO)

(5) As a step in facilitating the interoperation of M&S with $C^4I$ systems, evaluate the suitability of the HLA data exchange environment as a means to link M&S with $C^4I$ systems by fourth quarter FY 1996. (PR: DMSO)

(6) Identify M&S security requirements (e.g., speed of encryption, security management infrastructure, use of U.S. cryptographic equipment by allies, MLS) to appropriate development agencies in FY 1995, and work with them to establish interim solutions and standards. (PR: DoD C3I Authorities)

Figure 4-3. HLA Definition Process
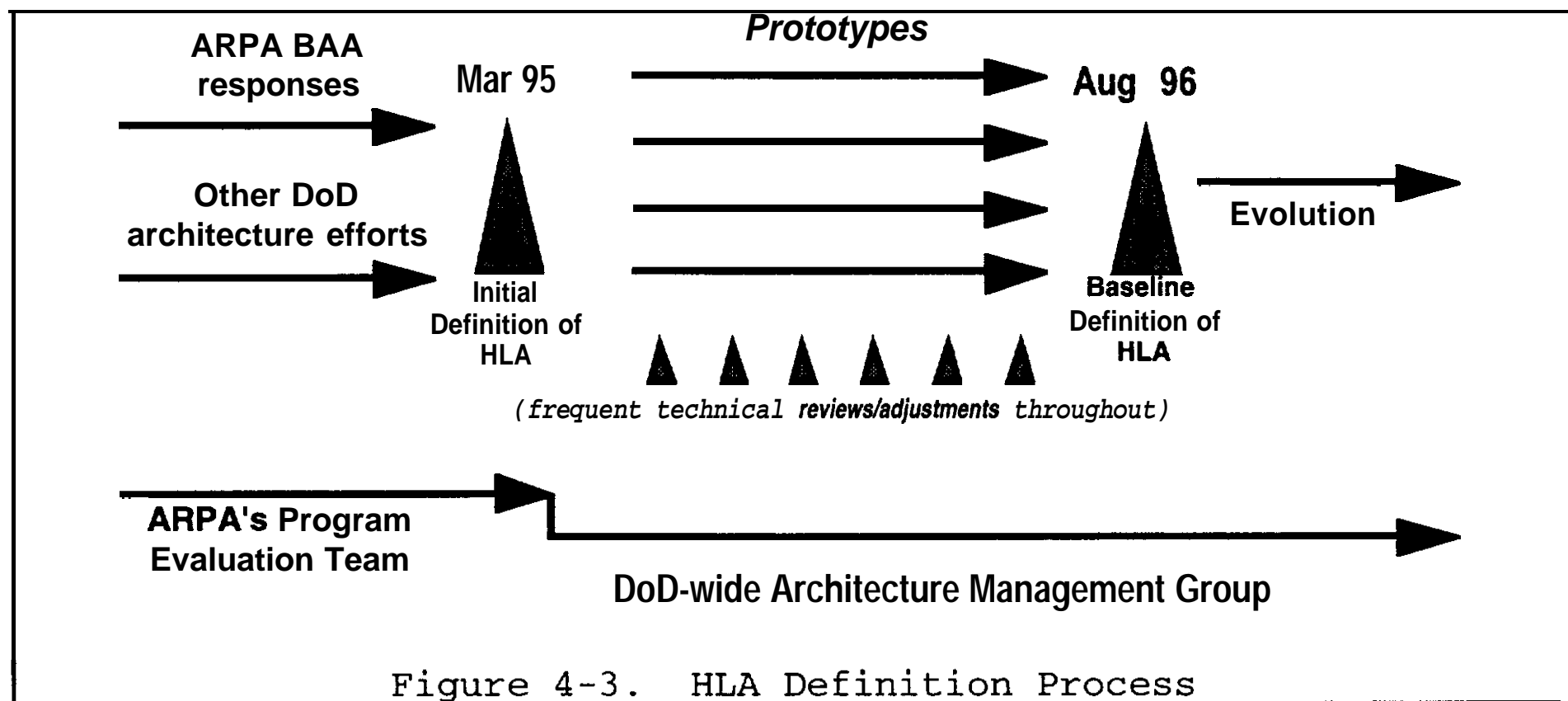
(7)  Develop prototypes by third quarter FY 1996 for implement ing and testing the HLA (from action B.2 .c. (3) , above) . (PR: AMG)

(8)  Evaluate the prototypes and baseline the HLA definition by fourth quarter FY 1996.  The full process from alternative concepts to architecture definition (Actions B.2. c.(2), B.2. c.(3),  B.2. c.(7), and B.2. c.(8)) is illustrated in Figure 4-3.  (PR: AMG)

( 9 ) Begin providing in FY 1995 supporting software usable by programs conforming to the HLA.  (PR: AMG)

(lo)  Establish a common technical means by fourth quarter FY 1996 to test compliance with the HLA.  (PR: AMG)

(11)  Review all ongoing DoD M&S projects and/or programs by second quarter FY 1997 for feasibility of immediately adopt ing the HLA.  If not immediately feasible, these reviews shall establish the date by which each program shall comply.  If a specific M&S project and/or program is unable to comply with the HLA, the developing Component must report the reason(s) for non-compliance to the DDR&E.  ( PR: DoD Components)

(12 ) Establish an oversight mechanism by second quarter FY 1997 to monitor M&S program progress towards compliance with the HLA.  (PR: USD (A&T) )

-(13)  Establish a process in FY 1995 for discussing architectural and related issues with the outside community; i.e. , defense industry,  the commercial sector, and academia.  ( PR : DMSO)

3.  Sub-Obj ective 1-2.  Develop conceptual models of the mission space (CMMS) to provide a common starting point for

strutting consistent and authoritative M&S representations, and to facilitate interoperability and reuse of simulation components.

     a.  <u>Discussion</u>.  The CMMS is a first abstraction of the real world and serves as a frame of reference for simulation development by capturing the features of the problem space. Those features are the entities involved in any mission and their key actions and interactions. The **CMMS** is a simulation-neutral view of the real-world, and acts as a bridging function between the warfighter, who owns the combat process and serves as the **authoritative** source for validating CMMS content, and simulation **developers**. Additionally, the **CMMS** provides a common viewpoint and serves as a vehicle for **communications** among warfighters, doctrine developers, trainers, C41 developers, analysts, and simulation developers. Such a foundation allows all concerned parties to be confident that DoD simulations are founded in operational realism.

     (1) The simulation development process diagramed in Figure 4-4 depicts a flow from the real world to simulation, a software representation of that world. Each simulation developer must start by **assembling** an understanding of how the operating forces perform their mission. This process is accomplished each time a simulation is developed. The developer performs a **front-end** analysis of the problem space, selecting the aspects of the real world to be represented and their resolution. While in the design phase, having selected those important aspects of the real world to model, the developer iterates back to the real world for additional information (e.g., greater detail, sequences, time to perform).
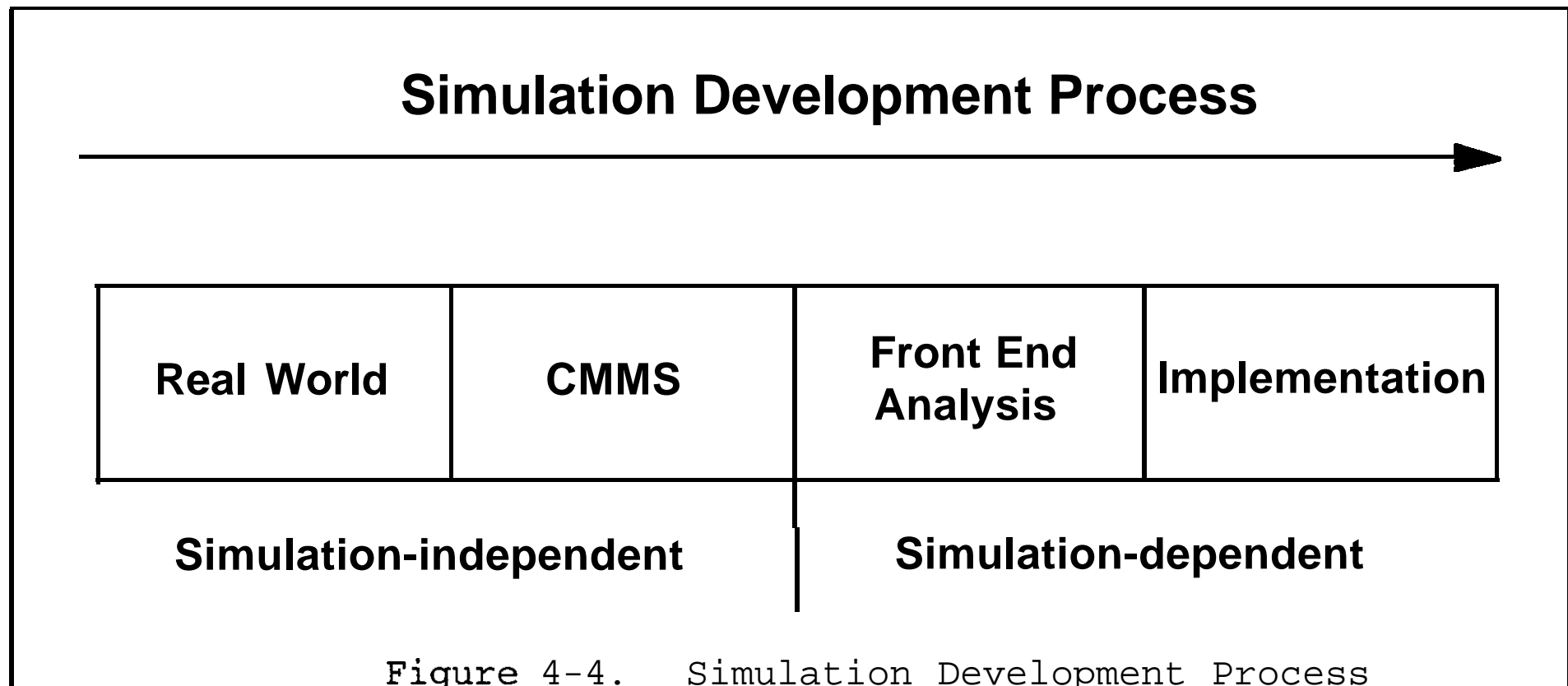
     **(2)** Currently, there are two serious problems with the manner in which this simulation development process is executed: 1.) different developers rely on different sources for the same information, yielding inconsistent pictures of the real world, and 2.) the information, obtained at considerable expense, is not maintained for use in future simulations. The CMMS will require reliance on authoritative sources and serve as the means for capturing, sharing, and evolving this information. As an automated representation of the real world, the **CMMS** will provide a common, easily accessible, *authoritative* starting point for design activity relating to Objectives 2, 3, and 4, and facilitate interoperability and reuse among simulations.

     b.  <u>Issues</u>:

     (1)  Process for further defining, evolving, and maintaining the **CMMSs**.

     (2) **Level** of detail to which the **CMMSs must** be developed.

     **(3)**  Determination of appropriate classification schema that facilitates information integration and reuse.

## Simulation Development Process

| Real World | CMMS | Front End Analysis | Implementation |
|---|---|---|---|

| Simulation-independent | Simulation-dependent |
|---|---|

Figure 4-4.   Simulation Development Process

(4) Availability of documentation and other authoritative sources describing the mission-space functions .

(5) Development respons ibi lit ies and funding.

(6) Requirements to allow distributed development.

(7) Determination of software tools.

(8) Ownership, authentication, and maintenance of CMMS .

c.   Actions:

( 1 ) In FY 1995 form CMMS technical support team, conduct research, and begin development of initial CMMS prototype leveraging work from other sources. (e.g. , Joint Mission Essential Task List, Universal Joint Task List (UJTL) ) .   ( PR: DMSO)

(2) In 1st quarter FY 1996, define CMMS technical framework.   ( PR : DMSO)

(3) In FY 1996, develop CMMS software environment and support ongoing CMMS activities by simulation developers.   (PR: DMSO )

(4) In  FY  1996, incorporate existing conceptual models ( including process models) into the CMMS as feasible.   (PR: DMSO )

(5)   Beginning in FY 1996, simulation developers voluntarily build their conceptual models in accordance with the

CMMS technical framework and provide them to DMSO for integration into the DoD-wide **CMMS.** (PR: Components)

(6) In **FY** 1997, complete initial version of **CMMS,** maintain and evolve **CMMS** on a continuing basis, and support ongoing Component CMMS projects. (PR: **DMSO)**

4. <u>Sub-Objective 1-3</u>. Establish data standards to support common representations of data in models and simulations.

a. <u>Discussion.</u> Data is critical to M&S. In the data area, the overarching objective is to enable data suppliers to provide the community affordable, timely, verified, and validated data to promote reuse and sharing of data, interoperability of models and simulations, and improved credibility of M&S results. The policies, procedures, and methodologies for data standards form general guidance for data used in environmental, systems and human behavior representations (Objectives **2, 3,** and 4, sections C, D, and E).

b. <u>Issues</u>:

(1) The need to establish data standards (e.g., data element definitions, data dictionary, data models, etc.) in compliance with DoD policy.

**(2)** The lack of DoD guidance on the establishment of data standards for complex data (e.g., probability of hit and/or kill, images, road networks) , nomenclature and **symbology.**

(3) The need to define requirements for supporting data and data standards in the distributed MSRR system.

c. <u>Actions</u>:

(1) Establish data modeling and standardization efforts in the M&S community in compliance with DoD Policy. Ongoing. (PR: **DMSO)**

(2) Develop extensions to data standards to include nomenclature, **symbology,** and complex data standards. Issue . initial M&S policy and procedures for data standards in FY 1996, complex data standards in **FY** 1996, nomenclature and **symbology** standards in FY 1997. (PR: **DMSO)**

(3) Develop the requirements for supporting data and data standards in the MSRR system by third quarter FY 1996. (See Sub-objective 5-3, subsection **F.4.)** (PR: **DMSO)**

c. <u>OBJECTIVE 2</u>. Provide timely and authoritative representations of the natural environment.

NOTE : W&A, resource repositories, and configuration control are addressed in Objective 5, section F.

1. <u>Discussion.</u> Models of military operations depend on interaction with representations of the natural environment including permanent and semi-permanent man-made features. Further realistic representation of military operations requires **integration** of weapons effects and resulting environments. This requires authoritative three-dimensional representations of the terrain, oceans, atmosphere, and space to include environmental quality issues (e.g. , conservation, pollution prevention) . These representations are complex in design and require significant funds and time to build. Therefore, the complexity should be commensurate with the simulation's functional requirement for detail given the scope of what is being modeled. Additionally, environmental representations must be seamless in terrain, ocean, atmosphere, and space boundary regions to present fully **integrated** data for M&S use. For example, M&S in the littoral region[14] can require **high** resolution interface between terrain, oceanographic, and atmospheric data and among process models of beach **trafficability, local** atmospheric effects, tides, waves, surf, and sediment transport. Because resource constraints prevent having current worldwide representations available off-the-shelf, a suitable, **cost-**effective process must be established to provide "just-in-time" production of these representations.

a. Terrain representation includes the configuration, composition, and representation of the surface of the earth, including its relief, natural features, permanent or semi-permanent man-made features, and related processes. Terrain representation includes terrain coverage including seasonal and diurnal variation such as grasses and snow, foliage coverage, tree type, and shadow. The terrain surface includes inland waters, and the sea floor bottom to the 20 meter depth curve. The representation also includes the mutual interaction of dynamic phenomena and the terrain.

b. Oceanographic representations include data on the ocean bottom (e.g. , depth curves and bottom contours) as well as processes required to model the natural and man-made changing surface (e.g. , sea state) and sub-surface (e.g. , temperature, pressure, salinity gradients, acoustic phenomena) conditions.

c. Atmospheric representations are developed in a zone from the earth's surface to the upper boundary of the troposphere and include:

(1) Particulate and aerosol data on haze, dust, and smoke (to include nuclear, biological, and chemical effects)

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[14] The littoral region is defined as 1) Seaward - the area from the open oceans to the shore that must be controlled to support operations ashore; 2) landward - the area inland from the shore that can be supported and defended directly from the sea.

**(2)** Data on fog, clouds, precipitation, wind, condensation (humidity), obscurants, contaminants, radiated energy, temperature, and illumination.

**(3)** process models for generating, moving, dispersing, and dissipating atmospheric phenomena in four-dimensional (i.e., three-dimensional spatial location over time) representations of both natural and modified environments (to include the effects conventional, nuclear, chemical, biological, and other weapons and/or collateral effects[15])
.

d. Ionosphere and space representations are developed beyond the upper boundary of the troposphere. These representations must include data on neutral and charged atomic and molecular partitles (including their optical properties) and the processes required to model transatmospheric and exoatmospheric ballistics, orbital dynamics, electromagnetic phenomena, aerospace, and astrodynamic relationships. Effects on satellite and spacecraft performance and communications caused by natural and human induced changes in the geomagnetic field and the presence of charged particles must be portrayed accurately.

**2. Sub-Objective 2-1.** Provide timely and authoritative representations of the terrain.

a. Issues:

(1) Definition of user community requirements in terms of the required feature data content, levels of resolution, accuracy, and fidelity for terrain representation.

**(2)** Development of standard, correlated terrain representations at multiple levels of detail.

**(3)** Availability of source data (e.g., imagery from overhead systems).

**(4)** Coordination of terrain representation production to reduce costs and improve data consistency and quality.

**(5)** Development of a cost-effective capability to rapidly produce standardized terrain data to meet Component needs, including the requirements of UCCs to support short-notice operational planning and mission rehearsal.

**(6)** Development of standard representations of terrain processes (e.g., thermodynamic and hydrologic models, soil strength, slump) and seasonal changes (e.g., foliage, ground cover, and reflectance).

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[15] Weapons and collateral effects environments include both the physical effects resulting from weapon detonations and accidents/incidents potentially associated with thegeneration, transport, and weapons employment of nuclear, biological, and chemical materials inwarandinOOTW.

**(7)** Development of a capability to represent terrain changes dynamically (e.g. , weapons and/or collateral effects, craters, earth moving, damage to structures), and diurnal changes (e.g., illumination, shadows, temperature, and reflectance) .

**(8)** Development of standard methods to link models and simulations that use terrain data of differing resolution.

**(9)** The production of gee-typical, vice gee-specific, terrain representations for training exercises.

(10) The accessibility and reuse of three-dimensional models of typical cultural features (e.g. , buildings, bridges) .

   b.   <u>Actions</u>:

        (1) Develop authoritative terrain prototype data sets to support M&S activities.   (PR: Executive Agent - DMA)

            (a)   Select geographic areas for prototyping by the third quarter of FY 1995.

            (b)   Specify the data resolution levels, fidelity, and accuracy required to support major M&S functional areas in FY 1995.

            (c)   Develop data dictionaries in FY 1996 for the feature content and attribution requirements of each M&S resolution level.

            (d) Define in FY 1996 the data structure, coding and attribution scheme, **symbology,** and metadata requirements.

            (e)   Generate prototype terrain data sets over selected geographic areas by second quarter FY 1996.

        **(2)** Once  developed, make all terrain representations available to the M&S community through the resource repository system.   Initiated in FY 1995.   Ongoing.   (PR: Executive Agent - DMA )

        **(3)** Demonstrate rapid terrain data generation capability for all specified M&S resolution levels from controlled (all-source) imagery and intelligence sources.   (PR: Executive Agent - DMA)

            (a)   In **FY 1995**, determine expected availability of source data and develop plans to meet any anticipated shortfall by appropriate liaison.   (PR: Executive Agent - DMA)

(b)    Select geographic areas and target M&S programs for **prototyping** rapid terrain database generation in FY 1995.

(c)    Demonstrate computer-assisted feature **ex**traction from multiple-source imagery, with data generalization techniques applied to generate multiple database resolution levels from single pass extraction in FY 1996.

(d) Demonstrate an initial capability in FY 1996 to produce, within 1 week, standard terrain data to meet M&S functional area requirements contained within a nominal 2500 km$^2$ area.

(e)    Demonstrate in FY 1997 the capability to produce standard terrain data to meet M&S functional area requirements contained within a nominal 2500 km$^2$ area (with three-dimensional terrain, including three-dimensional man-made features, reasonably attributed) , within 72 hours.

**(4)** Nominate data exchange standards to Assistant Secretary of Defense for Command, Control, **Communications** and Intelligence **(ASD(C$^3$I)),** as required in FY 1996.   (PR: Executive Agent - **DMA)**

**(5)** Demonstrate the capability to generate and/or receive and apply data updates to standard terrain representations, and document the configuration control process required in FY 1996.   (PR: Executive Agent - DMA)

**(6)** Develop authoritative terrain process representations, to include the interface with atmospheric and oceanographic effects (e.g., littoral regions), for selected M&S functional areas .   (PR: Executive Agent - DMA)

(a)    Document terrain process representations in existing weapons effects and vehicle mobility models to establish the baseline for subsequent specification of standard terrain process representations in FY 1995.   (PR: ARPA)

(b)    Establish standard process representations of soil mechanics for weapons effects, engineering earthworks, and ground vehicle mobility in FY 1996.

(c) Establish an enhanced set of standard terrain process representations (e.g., thermodynamic and hydrologic models) in FY 1997.

(7) Develop capabilities for dynamic terrain.   (PR: Executive Agent - DMA)

(a) Establish standard capabilities for multi-state objects (e.g., damaged structures, changes in vegetation) in FY 1996.

(b) Establish initial capabilities for dynamic terrain in FY 1997.

(c) Develop standard process representations for dynamic terrain in FY 1998.

**(8)** In FY 1997, develop a standard methodology for interconnecting simulations (live, virtual, and constructive) that use terrain models of differing resolution. (PR: Executive Agent - DMA)

3. <u>Sub-Objective 2-2</u>. Provide authoritative representations of the oceans.

a. <u>Issues</u>:

(1) Definition of user **community** requirements in terms of the required data content, levels of resolution, accuracy, and fidelity for ocean representation.

**(2)** Availability of source data (both bottom conditions, surface data, and the water column) .

**(3)** Development of standard, correlated, representations of the oceans.

**(4)** Identification and development of coordinated, cost-effective capabilities to produce certified oceanographic data.

**(5)** Development of authoritative process representations for the oceans to include natural and man-made effects.

**(6)** Development of a capability to interoperate and scale oceanographic models.

b. <u>Actions</u>:

(1) Determine expected availability of source data and develop plans to meet any anticipated shortfall by appropriate liaison in FY 1996. (PR: Executive Agent - TBD)

(2) Develop authoritative oceanographic prototype data sets -to support M&S activities. (PR: Executive Agent - **TBD)**

(a) Select geographic areas in FY 1996 (as required for littoral region interaction) and oceanographic conditions for **prototyping.**

(b) Specify the data resolution levels, fidelity, and accuracy required to support M&S functional areas in FY 1996.

(c) Develop data dictionaries for the feature content and attribution requirements of each appropriate M&S resolution level in FY 1996.

(d) Define, in FY 1996, the data structure, coding, and attribution scheme, **symbology**, and metadata requirements .

(e) Generate oceanographic prototype data sets in FY 1996.

**(3)** Once developed, make all ocean representations available to the M&S community through the resource repository system. Initiate in FY 1996. Ongoing. (PR: Executive Agent - TBD )

(4) Nominate data exchange standards to $ASD(C^3I)$, as required in FY 1996. (PR: Executive Agent - TBD)

**(5)** Demonstrate the capability to generate and/or receive and apply data updates to standard oceanographic databases from multiple sources and document the configuration control process required in FY 1997. (PR: Executive Agent - TBD)

**(6)** Develop authoritative oceanographic process representations to include the interface with associated terrain and atmospheric effects (e.g., littoral region shoreline, bottom, and wind conditions) for selected M&S functional areas. (PR: Executive Agent - TBD)

(a) Define an initial set of standard and **dynamic** process representations for the ocean environment in virtual and constructive simulations in FY 1997.

(b) Establish enhanced standard oceanographic process representations in FY 1998.

(c) Define and develop process representations for natural and man-made perturbations on oceanographic representations in FY 1998.

(7) Develop a standard methodology for understanding and managing the effects of interconnecting simulations using oceanographic models of **differing** resolution in FY 1998. (PR: Executive Agent – TBD)

4. <u>Sub-Objective 2-3</u>. Provide authoritative representations . of the atmosphere.

a. <u>Issues</u>:

(1) Definition of user community requirements in terms of the required data content, levels of resolution, accuracy and fidelity for atmospheric representations.

(2) Availability of source data.

**(3)** Development of standard, correlated, data representations of the atmosphere.

(4) Identification and development of coordinated, cost-effective capabilities to produce certified atmospheric data.

(5) Development of authoritative process representations for the atmosphere to include natural and man-made effects.

(6) Development of a capability to interoperate and scale atmospheric models.

b.  <u>Actions</u>:

(1) Determine expected availability of source data and develop plans to meet any anticipated shortfall by appropriate liaison in FY 1996.  (PR: Executive Agent - TBD)

**(2)** Develop authoritative atmospheric prototype data sets to support M&S activities.  (PR: Executive Agent - TBD)

(a)  Select geographic areas in FY 1996 (as required for littoral region terrain and ocean interaction) and atmospheric-conditions for prototyping.

(b) Specify the data resolution levels, fidelity, and accuracy required to support M&S functional areas in FY 1996.

(c)  Develop data dictionaries for the feature content and attribution requirements of each appropriate M&S resolution level in FY 1996.

(d) Define, in FY 1996, the data structure, coding, and attribution **scheme, symbology,** and metadata requirements.

(e)  Generate atmospheric prototype data sets by second quarter FY 1996.

**(3)** Once developed, make all atmospheric **representa**tions available to the M&S community through the resource repository system.  Initiate in **FY** 1996.  Ongoing.  (PR: Executive Agent - TBD)

**(4)** Nominate data exchange standards to ASD($C^3I$), as required in FY 1996. (PR: Executive Agent - TBD)

(5) Demonstrate the capability to generate and/or receive and apply data updates to standard atmospheric databases from multiple sources and document the configuration control process required in FY 1997. (PR: Executive Agent - TBD)

**(6)** Develop authoritative atmospheric process representations to include the interface with associated terrain effects (e.g., littoral regions) for selected M&S functional areas . (PR: Executive Agent - TBD)

(a) Define an initial set of standard and dynamic process representations for the atmospheric environment in FY 1998.

(b) Establish enhanced standard **atmospheric** process representations in FY 1998.

(c) Define and develop process representations for natural and man-made perturbations on atmospheric representations in FY 1998.

**(7)** Develop a standard methodology for understanding and managing the effects of interconnecting simulations using atmospheric models of differing resolution in FY 1998. (PR: Executive Agent - TBD)

**(8)** Develop authoritative representations of conventional, nuclear, chemical, biological, and other weapon effects. Initiate in FY 1996; complete in FY 1998. (PR Executive Agent - TBD)

**5.** Sub-Objective 2-4. Provide authoritative representations of space.

a. Issues:

(1) Definition of user **community** requirements in terms of the required data content, levels of accuracy, fidelity, precision, and resolution.

**(2)** Development of interoperable, internally consistent interfaces with other environmental representations.

**(3)** Availability and internal consistency of aerospace and astrodynamics source data.

b. Actions:

(1) Determine current availability, expected development schedules, and cost of appropriate source data and develop

plans to meet any anticipated shortfall through appropriate liaison by FY 1997. (PR: Executive Agent - TBD)

**(2)** Develop authoritative natural and manmade aerospace prototype data sets. (PR: Executive Agent - TBD)

(a) Select specific transatmospheric and space environmental regimes and conditions for **prototyping** in FY 1996.

(b) Specify data accuracy, resolution levels, fidelity, degrees of precision, and formats required to support M&S functional areas by FY 1997.

(c) **Develop, by FY 1997, data dictionaries** describing **location, feature content, lineage, current status, and** attribution information for all aerospace data and data sets, including their relationship to each M&S resolution level and the particular portions of aerospace and astrodynamic environmental representation to which they apply.

(d) Define the data structure, coding and **attri**bution scheme, **symbology,** and metadata requirements by FY 1997.

(e) Create an analytically useful depiction of the space environment by FY 1997.

(f) Demonstrate rapid, accurate, computer-assisted electronic, infrared, and radar data generation, modeling and display capabilities at all specified M&S resolution levels using controlled (all-source) imagery and intelligence information by FY 1997.

(3) Once developed, make all space representations available to the M&S community through the resource repository **system.** Initiate in FY 1996. Ongoing. (PR: Executive Agent - TBD )

(4) Nominate data exchange standards to ASD($C^3I$), as required, by second quarter FY 1996. (PR: Executive Agent - TBD)

(5) Demonstrate the capability to generate and **receive** data updates from multiple sources, and apply them to databases supporting engineering-grade synthetic environments (including full documentation of all appropriate configuration control and certification processes) by FY 1998. (PR: Executive Agent - TBD )

( 6 ) Develop authoritative aerospace and **astrodynamic** process representations for selected M&S functional areas and synthetic environments. (PR: Executive Agent - TBD)

(a) Define standard and dynamic aerospace and astrodynamic process representations by FY 1998.

(b) Establish enhanced standard aerospace and astrodynamic process representations, consistent with all appropriate synthetic environments by FY 1999.

(c) Adapt appropriate dynamic environmental depiction methods, including internally consistent spatial frames of reference, to networks of models and complex interactive simulations by FY 1998.

(7) Develop a standard methodology for understanding and managing the space-related effects of interconnecting simulations within aerospace and astrodynamic synthetic environmental representations of differing resolution, scale, and scope by FY 1999. (PR: Executive Agent - TBD)

D. OBJECTIVE 3. Provide authoritative representations of systems.

NOTE : W&A, resource repositories, and configuration control are addressed in Objective 5, section F.

1. Discussion. Systems include U.S., Allied, Coalition, and threat major platforms, weapons, sensors, units, life support systems, $C^4I$ systems, and logistics support systems. Authoritative representations of systems require models of the systems and their associated parameters which together provide V&V performance levels across a variety of conditions. In the aggregate this is a very large task and, for some systems (e.g., $C^4I$), a very difficult one.

2. Issues:

a. Development of community standards (e.g. , resolution, fidelity) for specifying representations of systems for use throughout the life-cycle of systems.

b. Coordination of M&S development programs to cost-effectively provide the required population of system representations.

c. Development of acceptable algorithms for aggregating representations of single systems into groups of entities that cooperate as a unit.

d. Disaggregation of aggregated representations.

3. Actions:

a.    Identify initial **common** object classes for representing systems beginning with platform representations, by second quarter FY 1996.   (PR: EXCIMS)

b.    As part of the architectural prototype efforts described under Objective 1, build examples, in FY 1995, of selected "prototype classes of objects representing systems.   (PR: AMG)

c.    Assign Executive Agent development responsibility for **common** object classes (e.g., vehicles, aircraft, missiles, spacecraft) , on the basis of current responsibility for **real**-world, physical entities by fourth quarter FY 1996.   (Note: owning organizations maintain responsibility for each specific example within an object class.)   (PR: **USD(A&T)**)

d.    Develop the system models and simulations **required** to satisfy the full range of DoD needs.   Compile initial **require**-ments by third quarter FY 1996; assign responsibilities by FY 1997.   (PR: DoD Components)

e.    Once developed, make all system representations available to the M&S community through the resource repository system.   Initiate in FY 1996.   Ongoing.   (PR: DoD Components)

f.    Develop methodologies, techniques, and algorithms by FY 1997 to facilitate implementation of aggregated representations of entities and disaggregation of higher-level representations into entities.   (PR: To be determined **(TBD)**)

E.   OBJECTIVE 4.   Provide authoritative representations of human behavior.

. NOTE:   **VV&A**, resource repositories, and configuration control are addressed in Objective 5, section F.

1.   Discussion.   Representations of humans and their behavior include human capabilities and limitations; individual and group performance; effects of organizational configuration and environment on performance; command, control and communications; and doctrine and tactics.   Missions include combat operations, 00TW (e.g., peace-keeping, humanitarian relief, drug interdiction), and production and logistics with specific attention to joint operations.

2. Sub-objective 4-1.   **Develop** authoritative representations of individual human behavior[16].  .

a. ‾ Issues:

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[16] Individual behavior includes both physiological and cognitive processes under varying situations and environmental conditions (e.g., morale, fatigue, stress, fear, and unpredictable behavior).

(1) Extension of existing models of combat operations to include individual combatants.

(2) Development of generic models of individual human capabilities, limitations, and performance (physiological and psychological).

(3) Development of the capability to rapidly construct models of individual human behavior for specific applications on demand.

b.  Actions:

(1) Establish baseline behavioral model architectures and representational approaches by fourth quarter FY 1996.  (PR: TBD )

(2)  Establish a common behavioral model architecture by forth quarter FY 1997.  (PR: TBD)

(3)  Issue guidelines for the development of accredited behavioral representations of individual combatants by second quarter FY 1997.  (PR: TBD)

(4) Develop operational definitions of behavioral variables[17] and categories[18] relevant to individual humans, and establish requirements and priorities for modeling these aspects of individual human behavior.  Initiate in FY 1996.  Complete by fourth quarter FY 1997.  (PR: TBD)

(5)  Develop initial prototypes of selected generic components, specified in terms of the above behavioral variables and categories, for models of individual human behavior in FY 1997.  (PR: TBD)

(6) Once developed, make all representations of individual human behavior available to the M&S community through the resource repository system.  Initiate in FY 1996.  Ongoing. (PR: TBD)

(7) Develop standardized interfaces to facilitate the reuse of generic model components in different models of individual human behavior by FY 1997.  (PR: TBD)

(8) Develop guidelines and a methodology for assessing requirements for modeling individual humans in M&S applications .  Provide interim guidelines in FY 1996, final guidelines in FY 1996.  (PR: TBD)

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[17] Behavioral variables include level of fidelity, resolution, and performance measures

[18] Behavioral categories include sensory, perceptual, physical, cognitive, social, and emotional behavior.

(9) Develop tools and techniques to significantly im-
prove existing capabilities to acquire knowledge about individual
human performance by FY 1998. (PR: TBD)

(10) Develop models of individual human behavior using
generic model components. Integrate models of human behavior into
combat models and other applications. Initiate in FY 1997;
ongoing. (PR: TBD)

3. Sub-objective 4-2. Develop authoritative representations
of the behavior of groups and organizations. [19]

a. Issues:

(1) Extension of existing models of combat operations
to cover friendly, threat, and neutral forces over all levels and
functional areas.

(2) Development of generic representations of the be-
havior of groups and organizations or modeling a wide variety of
potential adversaries and non-combatants (e.g., insurgents, ter-
rorists, drug cartels). This also includes social, political, or
economic behaviors that may be required to adequately portray
OOTW .

(3) Development of the capability to rapidly con-
struct models of group and organizational behavior for specific
applications on demand.

b. Actions:

(1) Issue guidelines for the development of accredit-
ed behavioral representations of friendly, neutral, and hostile
force organizations in FY 1996. (PR: TBD)

(2) Establish requirements and priorities for model-
ing OOTW in FY 1996. (PR: TBD)

(3) Develop representations of C31 structures and
processes for military and non-military organizations. Initiate
in FY 1995; complete in FY 2000. (PR: TBD)

(4) Develop operational definitions of behavioral
variables and categories relevant to groups and organizations, and
establish requirements and priorities for modeling these aspects
of group and organizational behavior. Initiate in FY 1996.
Complete by fourth quarter FY 1997. (PR: TBD)

(5) Develop initial prototypes of selected **generic**
components, specified in terms of the behavioral variables and

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[19] Group and organizational behavior addresses group dynamics, leadership, team decision processes, doctrine, and
tactics.

categories developed in Action E.3.b. (4) above, for models of group and organizational behavior in **FY** 1996. (PR: .TBD)   . .

(6) Once developed, make all representations of group and organizational behavior available to the M&S community through the resource repository system. Initiate in **FY** 1996; ongoing. (PR: TBD)

(7) Develop standardized interfaces to facilitate the reuse of generic model components in different models of group and organizational behavior by **FY** 1997. (PR: TBD)

(8) Develop guidelines and a methodology for assessing requirements for modeling groups and organizations in M&S applications. Develop interim guidelines in **FY** 1996, final guidelines in **FY** 1997. (PR: TBD)

(9) Develop tools and techniques to significantly improve existing capabilities to acquire knowledge about group and organizational performance by **FY** 1998. (PR: TBD)

**(lo)** Develop models of group and organizational behavior using generic model components. Integrate models of group and organizational behavior into combat models and other applications. Initiate in **FY** 1997; ongoing. (PR: TBD)

F. OBJECTIVE 5. Provide a M&S infrastructure to meet developer and end-user needs.

1. Discussion. The M&S infrastructure consists of Component M&S systems and applications; W&A; policy, procedures and support; resource repositories; communications; and a management organization to coordinate use of M&S resources.

2. Sub-objective 5-1. Field M&S systems in adequate numbers to meet end-user needs

a. Issues:

(1) Identification of M&S requirements.

(2) Total M&S system costs to support DoD Components.

(3) Acquisition and fielding of the appropriate numbers and types of M&S by Components to satisfy overall DoD capability needs.

(4) Increasing the utility of existing and future models and simulations by making them **DIS-compliant.**

b. Actions:

(1)　Identify M&S cost drivers and develop **cost**-effective fielding options by FY 1997.　(PR: DoD Components)

**(2)**　Establish Component M&S requirements, with due regard for the needs of the entire DoD.　Ongoing.　(PR: DoD Components)

**(3)** Report Component M&S requirements in terms of capability and accessibility, in each of the three functional areas (training, analysis, acquisition) , to DMSO within 6 months of the publication of this DoD M&S Master Plan, "and update this report as changes occur.　(PR: DoD Components)

**(4)** Plan, program, and budget for the fielding and interconnection of models and simulations.　Ongoing.　(PR: DoD Components)

**(5)**　Phase out obsolescent M&S systems and research programs.　Ongoing.　(PR: DoD Components)

3.　<u>Sub-objective</u> 5-2.　Develop methodologies, standards, and procedures for the W&A of models and simulations and the W&C of data.

a.　<u>Discussion</u>.　V&V of models, simulations, and data are essential to gain the confidence of user organizations that M&S outcomes are representative of the real world, that they are **rea-sonably** correct, and that the models and simulations are **accept-**able for a specific purpose.　V&V should be performed during the development of M&S and as part of M&S life-cycle management. Users must also properly accredit or certify each model, simula-tion, or data set as a prerequisite to its employment for each specific application.

b.　<u>Issues</u>:

(1)　Development of standards and procedures for V&V.

**(2)** Development of standards and procedures for accreditation.

**(3)**　Development of standardized automated tools to support **VV&A.**

**(4)** Development of data certification standards and procedures, to include metrics to describe data quality.

.**(5)** Maintenance of the history of W&A and W&C **activities** and their results.

c.　<u>Actions</u>:

(1)   Publish a DoD document establishing policy and assigning responsibilities for W&A of M&S.   Coordinate in FY 1995.   Promulgate in FY 1996.   (PR: **USD(A&T)**)

**(2)** Develop prototype applications of W&A to assess the trade-offs between the cost and time required for W&A (using varying procedures) of M&S in various categories and the M&S improvement achieved under varying model circumstances (such as the maturity and complexity of the models) .   Perform **pilot** W&A efforts in FY 1995 and **FY** 1996.   (PR: **MSWG**)

**(3)**   Establish general W&A standards and procedures for M&S applications and specific standards and procedures as required for each M&S category in FY 1996.   (PR: **USD(A&T)**)

**(4)** Provide on-call technical support services to accreditation authorities beginning in FY 1996.   (PR: **DMSO**)

**(5)**   Publish a DoD document setting **policy** and assigning responsibilities for **VV&C** of data; coordinate **in** FY 1996; promulgate **in** FY 1997.   (PR: **USD(A&T)**)

**(6)** Establish **VV&C** standards and procedures for M&S applications in FY 1996.   (PR: **USD(A&T)**)

**(7)** Develop metrics for measuring data quality by fourth quarter FY 1996.   (PR: DMSO)

**(8)** Once W&A or W&C has been performed, make histories of activities and results available to the M&S coromunity through the resource repository system.   Initiate in FY 1996. Ongoing.   **(PR:** DoD   Components)   .

   **4.   <u>Sub-objective 5-3</u>.**   Provide a repository system to facilitate developer and end-user access to M&S resources.

      a.   <u>Discussion.</u>   The Department of Defense must establish a distributed MSRR[20] system to efficiently and effectively provide the community with timely, verified, and validated data, metadata, algorithms, models, simulations, and tools.   The MSRRS should also provide background information (e.g., model assumptions, source of data, classification of data, range of validity of algorithms, **VV&A** and/or **VV&C** history) .   This will promote reuse and sharing of M&S resources and will improve credibility of M&S results.   The repository will provide tools for configuration management and for accessing, browsing, and retrieving M&S resources.

      b.   <u>Issues;</u>

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20 The Modeling and Simulation Resource Repository system is a functionally oriented, intemetted, distributed system for sharing and maintaining models, simulations, data, metatdata, algorithms, and tools.

(1) Access and reuse of M&S resources across the .
Department of Defense.

**(2)** Identification of authoritative data sources for M&S resources.

**(3)** Configuration control of M&S reusable resources (e.g., data, algorithms, models, simulations, tools).

**(4)** Identification of data security requirements.

c. Actions:

**(1)** Develop a distributed MSRR system providing: (a) directories/catalogs; (b) data standardization resources (e.g., process and data models, data dictionary); (c) reusable data, algorithms, models and simulations; and (d) tools for browsing and accessing, linking across resources, configuration management, etc. Develop an unclassified interim MSRR (iMSRR) repository system in FY 1995; classified **iMSRR** in FY 1996. Complete Baseline I System FY 1997; provide Baseline II System FY 1998. Initiate DoD-wide distribution in first quarter FY 1999. (Repository requirements for authoritative representations of the environment, systems, humans and their behavior are being provided under Objectives **2, 3,** and 4, sections B., C., and E.) (PR: **DMSO)**

(2) Develop a M&S taxonomy for use in identifying authoritative data sources. Establish responsibilities and provide a directory to authoritative data sources as part of the **MSRR.** Initial directory and assignment of responsibilities will be completed in FY 1995. (PR: **DMSO)**

**(3)** Define specific M&S data security requirements for access across repositories in FY 1996. (PR: **DMSO)**

**(4)** Develop configuration control procedures and tools to access, modify, and update the resources (e.g. , process models, data models, directories, data, algorithms, models **and** simulations, authoritative data sources) in the **MSRR.** Prototype by FY 1997; provide limited operational capability by second quarter FY 1998. (PR: **DMSO)**

5. Sub-objective 5-4. Provide a communications infrastructure adequate to meet M&S user needs.

a. Issues:

"(1) Transition of the current DSI to an operational service with improved reliability and increased bandwidth.

**(2)** Utilization of Defense Information Infrastructure and commercial communication services.

(3) Utilization of radio frequency (RF) communications (e.g. , satellite communications, Single Channel Ground Airborne Radio System, International Maritime Satellite) to support M&S and its interface with $C^4I$ systems.

**(4)** Accommodation of large numbers of operational users involved in large numbers of simultaneous simulation exercises.

**(5)** Utilization of improved encryption devices under development by National Security Agency to provide higher capacity than those currently used on the DSI.

**(6)** Implementation of MLS.

b. Actions:

(1) Provide DSI **communications** services to ensure: that M&S user needs are met. Ongoing. (PR: ASD($C^3I$))

**(2)** Broaden the range of alternative communications means to support the M&S community, including **commercial** services and RF links. Ongoing. (PR: ASD($C^3I$))

**(3)** Obtain appropriate encryption devices to support classified M&S. Ongoing. (PR: DoD Components)

**(4)** Advocate M&S requirements in the development of emerging communications standards (e.g. , multicasting and resource reservation) . Ongoing. (PR: DMSO)

**(5)** Provide MLS to link simulation participants in FY 1999. (PR: ASD($C^3I$))

**6.** Sub-objective 5-5. Provide operational support for the effective, efficient, and responsive application of world-wide simulation capabilities to meet user (e.g. , operating forces, acquisition managers, staff analyst) needs.

a. Discussion: There is a need for a central **organiza**tion to advise users of M&S suitability, to coordinate M&S asset availability, to provide useful information on M&S support requirements and practices, and to coordinate user requests for M&S assets in support of mission needs.

b. Issues:

(1) Coordinated utilization of DoD's simulation assets.

**(2)** Coordination of support for the planning, set-up, and execution of M&S supported activities in an operationally responsive, cost-effective manner.

**(3)** Establishment of a central activity for obtaining M&S support.

**(4)** Identification of requirements to conduct distributed simulation exercises.

**(5)** Coordination of outside demands for M&S support to minimize the impact on owning organizations.

    c. <u>Actions</u>:

(1) Establish a M&S Operational Support Activity **(MSOSA)** as an operations support activity to coordinate utilization of M&S assets among DoD Components. The MSOSA will assist M&S users in the planning, setup, execution, and monitoring of M&S events. Initiate study and coordination in FY 1995; designate responsible organizations by FY 1996; make **operational** by FY 1997. (PR: **USD(A&T)**)

**(2)** Identify focal points for each Component to work with the MSOSA to plan and coordinate use of distributed simulation assets. Identify in FY 1996. (PR: DoD Components)

**(3)** Identify notional requirements for distributed simulation exercises by FY 1997. (PR: DoD Components)

G. <u>OBJECTIVE 6</u>. Share the benefits of M&S.

1. <u>**Sub-objective 6-1**</u>. Quantify the impacts of M&S.

    a. <u>Discussion</u>. Achieving the DoD M&S vision requires more than just providing technical capabilities. Users must be convinced that M&S support of their operations is both **operationally** effective and cost effective. Thus, it will be necessary to analyze and demonstrate the use of M&S to support specific functional needs. Quantitative measures of the benefits that clearly demonstrate the impact of M&S must be developed. The results will be disseminated to the Department of Defense, Congress, other government agencies, and industry.

    b. <u>Issue</u>. Development of quantitative measures (e.g., readiness impact, cost savings and effectiveness) of the benefits of M&S to support investment decisions.

    c. <u>Actions</u>:

(1) Develop metrics to allow assessment of the utility of M&S in FY 1995. (PR: DoD Components)

**(2)** Collect and analyze data from ongoing efforts, planned experiments, and demonstrations to assess the impacts of M&S . Initiate in FY 1995, and maintain as a continuing activity. (PR: DoD Components)

(3) Establish the DoD-wide impact of M&S based on Component inputs from Action G.1.c. (2) above. (PR: DMSO)

2. <u>Sub-objective 6-2</u>. Education of potential M&S users.

a. <u>Discussion</u>. Managers need to be educated about the advantages and disadvantages of different M&S applications and the functions that they support. New users of models and simulations need instruction on how to set up their own models and simulations .

b. <u>Issue</u>. Expansion of user awareness and sharing of information across the M&S community.

c. <u>Actions</u>:

(1) Conduct M&S demonstrations addressing user needs. Ongoing. (PR: DoD Components)

**(2)** Expand the M&S Information System to include a broad knowledge base supporting the M&S community's development efforts in FY 1996. (PR: DMSO)

**(3)** Develop and maintain information papers and short courses on M&S beginning in FY 1996. (PR: DoD Components)

(4) Conduct and participate in seminars, symposia, and workshops on M&S. Ongoing. (PR: DoD Components)

**3.** <u>Sub-objective 6-3</u>. Support hi-directional technology transfer with other government agencies, industry, and allied nations.

a. <u>Discussion.</u> Technology transfer with other government agencies, private industry, and allied nations will promote dual-use and lead to improved capabilities by both DoD and non-DoD organizations. Technology transfer will be promoted only when appropriate and consistent with protection of U.S. Government proprietary intellectual property and security policy.

b. <u>Issues</u>:

(1) Promotion of faster and more extensive technology transfer with other government agencies, industry, and allied nations.

(2) Establishment of international standards for M&S.

(3) Establishment of security policy regarding the release of models and data bases of U.S. and threat capabilities.

c.  Actions:

(1) Provide cost-effective, on-line access to technical information provided by the Components by fourth quarter FY 1996.   (PR: DMSO)

(2) Conduct regular and frequent technology exchange meetings beginning in FY 1996.   (PR: DoD Components)

(3) Invite other government agencies, industry, universities, and allied nations to observe or participate in M&S experiments and demonstrations, seminars, workshops, and international working groups (e.g., North Atlantic Treaty" Organization Research Study Groups).  Begin in FY 1995, and maintain as a continuing activity.  (PR: DoD Components)

(4) Nominate evolving DoD simulation standards (e.g., DIS) for adoption by the International Standards Organization by FY 1996.   (PR: DDR&E)

(5) Provide representation to all standards development bodies potentially involving M&S (e.g., Object Management Group, Open Systems Foundation, National Institute for Standards and Technology) by third quarter FY 1995 to ensure that DoD needs are satisfied.   (PR: TBD)

(6) Develop security policy guidance concerning the release of models and data bases of U.S. and threat capabilities by fourth quarter FY 1996.   (PR: TBD)

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